hydroAMP
Asset Management Partnership

# *hydroAMP*
## *equipment condition assessments*

USACE Asset Management Risk & Reliability Workshop
Alexandria, VA
August 15-18, 2006

Presented by Lori Rux, PhD, PE
Hydroelectric Design Center

Hydro Québec

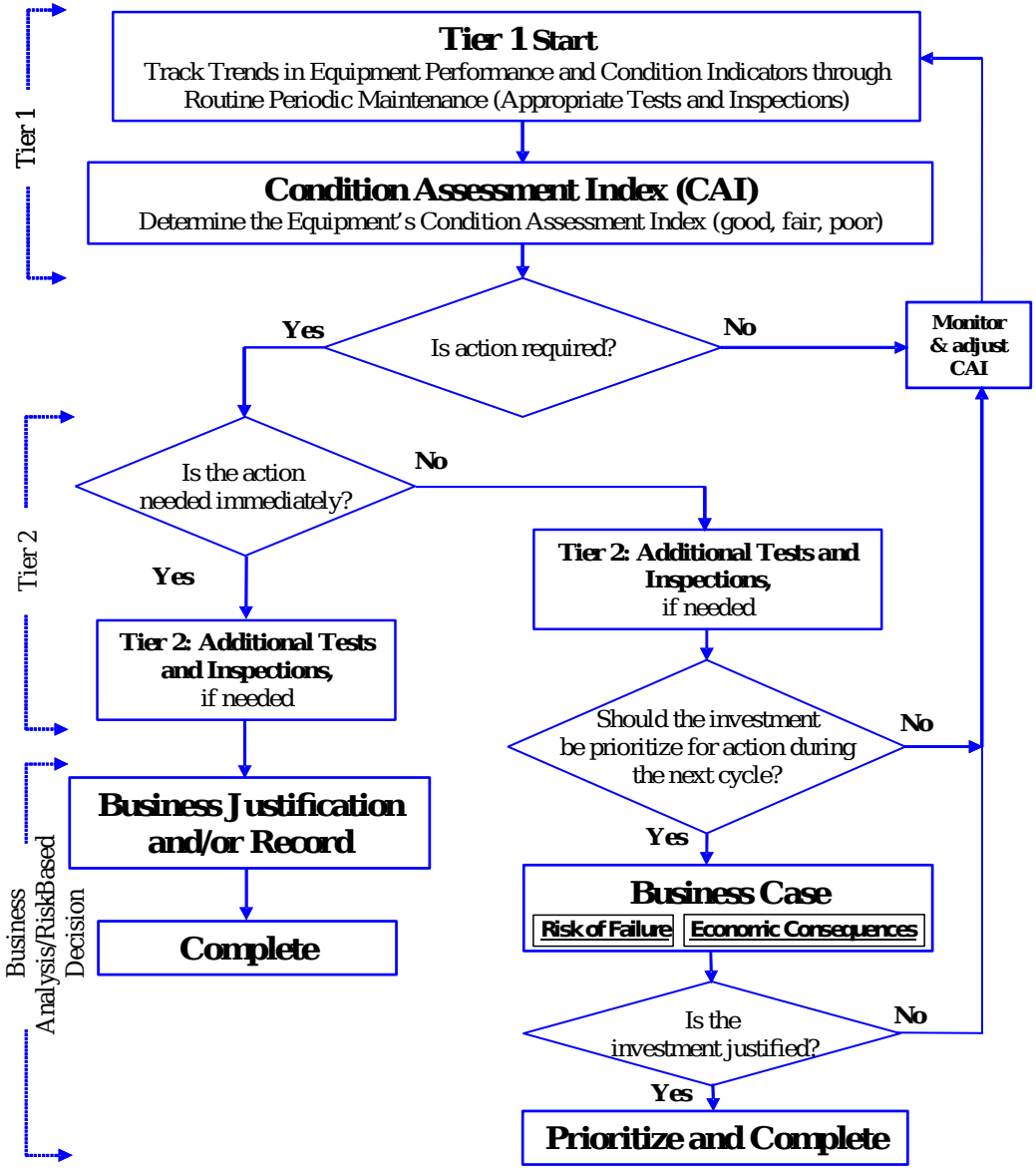
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

US Army Corps of Engineers

Bonneville Power Administration

# hydroAMP Framework

hydroAMP
Asset Management Partnership



# *Condition Assessment Guides*

hydroAMP
Asset Management Partnership

Multi-agency technical teams have developed condition assessment guides for:

- Turbines
- Generators
- Transformers
- Circuit Breakers
- Governors
- Exciters
- Surge Arresters
- Emergency Closure Gates & Valves
- Cranes
- Compressed Air Systems
- Station Batteries

# *Tier 1 Condition Assessment*

hydroAMP
Asset Management Partnership

- Appropriate ***Condition Indicators*** have been identified for each type of equipment.
- Condition Indicators are scored based on tests, measurements, and inspections that are normally performed during routine O&M activities.
- Results are combined into a ***Condition Index*** with a scale of 1-10; higher is better.
- Mid- to low-range values may trigger actions such as a repair or Tier 2 evaluation.

# *Tier 2 Condition Assessment*

hydroAMP
Asset Management Partnership

- In-depth, non-routine tests or inspections that may be invasive and/or require specialized equipment and expertise not normally found at the project.
- Results are used to adjust the Condition Index score (either up or down).
- When performed, adds confidence to the assessment results and conclusions.

# *Data Quality Indicator*

hydroAMP
Asset Management Partnership

- A stand-alone indicator used to reflect the quality of information available for performing the condition assessment.
- Recognizes that data may be missing, out of date, or of questionable integrity.
- Poor data could affect the accuracy of individual condition indicator scores as well as the validity of the overall Condition Index.
- Provides a means to evaluate and record confidence in the final Condition Index.

# *Condition-based Alternatives*

hydroAMP
Asset Management Partnership

| ***Condition Index*** | ***Suggested Action*** |
|---|---|
| ≥ 7.0 and ≤ 10 (Good) | Continue O&M without restriction. |
| ≥ 3.0 and < 7.0 (Fair) | Continue operation but reevaluate O&M practices. Consider Tier 2 tests. |
| ≥ 0 and < 3.0 (Poor) | Immediate evaluation including Tier 2 testing. Consultation with experts. Adjust O&M as prudent. |

# *Unit and Station Indices*

hydroAMP
Asset Management Partnership

- Individual equipment condition assessment results can be combined to develop aggregated assessments.
  - Unit Index – Complete power train
  - Station Index – Entire generating station

# *Generator Example*

hydroAMP
Asset Management Partnership

Tier 1 Condition Indicators (stator and field windings):

- O&M history
- Physical inspection
- Insulation resistance and polarization index
- Winding age

Condition Indicators are scored. Results are weighted and summed to calculate the Condition Index.

Data Quality Indicator is scored.

# *Summary of Tier 1 Stator Assessment*

hydroAMP
Asset Management Partnership

| Condition Indicator | Score | Weighting Factor | Total Score |
|---|---|---|---|
| O&M History *(0,1,2,or 3)* | **2** | 1.18 | 2.36 |
| Physical Inspection *(0,1,2,or 3)* | **3** | 1.18 | 3.54 |
| Insulation Resistance and Polarization Index *(0,1,2,or 3)* | **3** | 0.58 | 1.74 |
| Winding Age *(0,1,2,or 3)* | **0** | 0.39 | 0 |
| ***Stator Condition Index (0 – 10)*** | | | **7.6** |
| ***Data Quality Indicator (0, 4, 7, or 10)*** | | | **7** |

# *Tier 2 Tests*

hydroAMP
Asset Management Partnership

Tier 2 Toolbox (stator, rotor, and core):

- DC ramp
- High-pot
- PDA
- PF measurements
- Ozone
- Pole drop
- Blackout
- Loop
- EL CID
- Wedge tightness
- Other specialized tests

Results are used to refine the Tier 1 score.

Data Quality Indicator may be adjusted also.

# *Tier 1 Condition Indicator Scoring*

hydroAMP
Asset Management Partnership

Condition assessment guides provide instructions for scoring Tier 1 Condition Indicators.

| **Table 1 – Stator Winding Operation & Maintenance History Scoring**<br><br>**Results**<br>**Stator Condition**<br><br>**Indicator Score** | |
|---|---|
| Operation and maintenance normal. | 3 |
| Some abnormal operating conditions experienced and/or additional maintenance above normal occurring. | 2 |
| Significant operation outside normal and/or significant additional maintenance is required; forced outage occurs; outages are regularly extended due to maintenance problems; similar units are problematic. | 1 |
| Repeated forced outages; maintenance not cost | |

# *Tier 2 Tests and Condition Index Adjustments*

hydroAMP Asset Management Partnership

Condition assessment guides also provide criteria for using Tier 2 test results.

**Table 14 – Ozone Scoring**

| **Test Results to Condition Index** | **Adjustment to Stator** |
|---|---|
| Ozone levels less than 0.05 ppm. | Add 0.5 |
| Ozone levels between 0.05 and 0.1 ppm. | No Change |
| Ozone levels between 0.1 and 1.0 ppm. | Subtract 1.0 |
| Ozone levels above 1.0 ppm. | Subtract 2.0 |

# *hydroAMP Data Management*

hydroAMP
Asset Management Partnership

Data is stored in a secure web-accessible database.

- The database stores and reports Tier 1 condition assessments.
- The database can import data from FEMS/MAXIMO.
- It is expandable to include new plants and equipment and Tier 2 data.

# hydroAMP Database: Main Page

Welcome to HydroAMP!

Aging and deteriorating equipment poses significant risk to hydroelectric equipment reliability and may result in low generating unit availability. Significant investment in replacing, repairing or refurbishing existing generation and support equipment within hydroelectric projects is required to assure the continued viability of hydropower assets. The four organizations involved in hydroAMP, the Bureau of Reclamation (BOR), Hydro-Québec (HQ), the US Army Corps of Engineers (COE) and the Bonneville Power Administration (BPA), joined together to develop a common framework or process to streamline, simplify and improve the evaluation and documentation of the condition of hydroelectric equipment and facilities in order to support condition-based prioritization of hydropower asset business decision-making.

A two-tiered approach for assessing equipment condition and risk of failure for hydropower equipment was developed. Tier 1 of the condition assessment process incorporates test results and/or inspections that are normally obtained during routine operation and maintenance activities. These condition indicators are combined to compute an equipment Condition Index. Tier 2 of the assessment relies on more in-depth, non-routine test results and inspections requiring specialized knowledge to further refine the equipment Condition Index.

This website represents an additional effort that was developed in order to allow plants and agencies to input their equipment condition data into a single database in a common format. It also allows for individual plant/utility analysis and reporting.

Please select an option from the list below:

**Condition Assessments**
**Input equipment condition data for tier 1 assessment.**

**Equipment**
**Add, update and delete equipment for specific plants.**

**Reports**
**View and export condition assessment reports.**

**My Account**
**View and make changes to your account.**

**Help**
**Need help? Have comments?**

**What's New**

- 12/30/2005 - HydroAMP is now live and ready for use. Please take some time to familiarize yourself with the menu options at the top. Please contact the System Administrator for any questions or concerns.

**Assessment Guides**

- Turbine (pdf)
- Generator (pdf)
- Circuit Breaker (pdf)
- Governor (pdf)
- Excitation System (pdf)
- Transformer (pdf)
- Battery (pdf)
- Compressed Air System (doc)
- Crane (doc)
- Surge Arrester (pdf)
- Emergency Closure Gates and Valves (pdf)

# Tier 1 Generator Stator Assessment

hydroAMP
Asset Management Partnership

## Tier 1 Condition Assessment

**Generator Stator**

| | | | |
|---|---|---|---|
| Plant: | **Chief Joseph** | Unit: | 10 |
| Stator Winding Manufacturer: | Westinghouse | Stator Insulation Type: | Thermoplastic Clas |
| Rated Capacity: | 92.92 (MVA) | Power Factor: | 0.95 |
| Voltage Rating: | 13.8 (kV) | | |

**Tier 1 Generator Stator Condition Assessment**

*(For Instructions on indicator scoring, please refer to the condition assessment guide)*

| No. | Condition Indicator | | Score | x Weighting Factor = | Total Score |
|---|---|---|---|---|---|
| 1 | Operation & Maintenance History | Significant abnormal Operation or Maintenance | 1 | 1.18 | 1.18 |
| 2 | Physical Inspection | Inspection Shows some deterioration | 2 | 1.18 | 2.36 |
| 3 | Insulation Resistance and Polarization Index | Results are Normal and similar to Previous tests | 3 | 0.58 | 1.74 |
| 4 | In Service Date: | 1985 | 2 | 0.39 | 0.78 |
| | Stator Condition Index | | | | 6.1 Fair |

| | | |
|---|---|---|
| Data Quality Indicator | All completed within the normal testing frequency. | 10 |

**Note: Your Condition Assessment is not completed until you save!**

**Certification Information**

Last Assessment Date: **9/30/2005**

Last Approval Date: **9/30/2005**

Refresh | Save Assessment | Approval Review

Comment on Update:

# hydroAMP Database: Generator Summary

hydroAMP
Asset Management Partnership

View and export reports.

**Report Viewer**

New Report

Printing: For best results, export and print from Adobe Acrobat or Microsoft Excel

Zoom: 100% Export: HTML Export

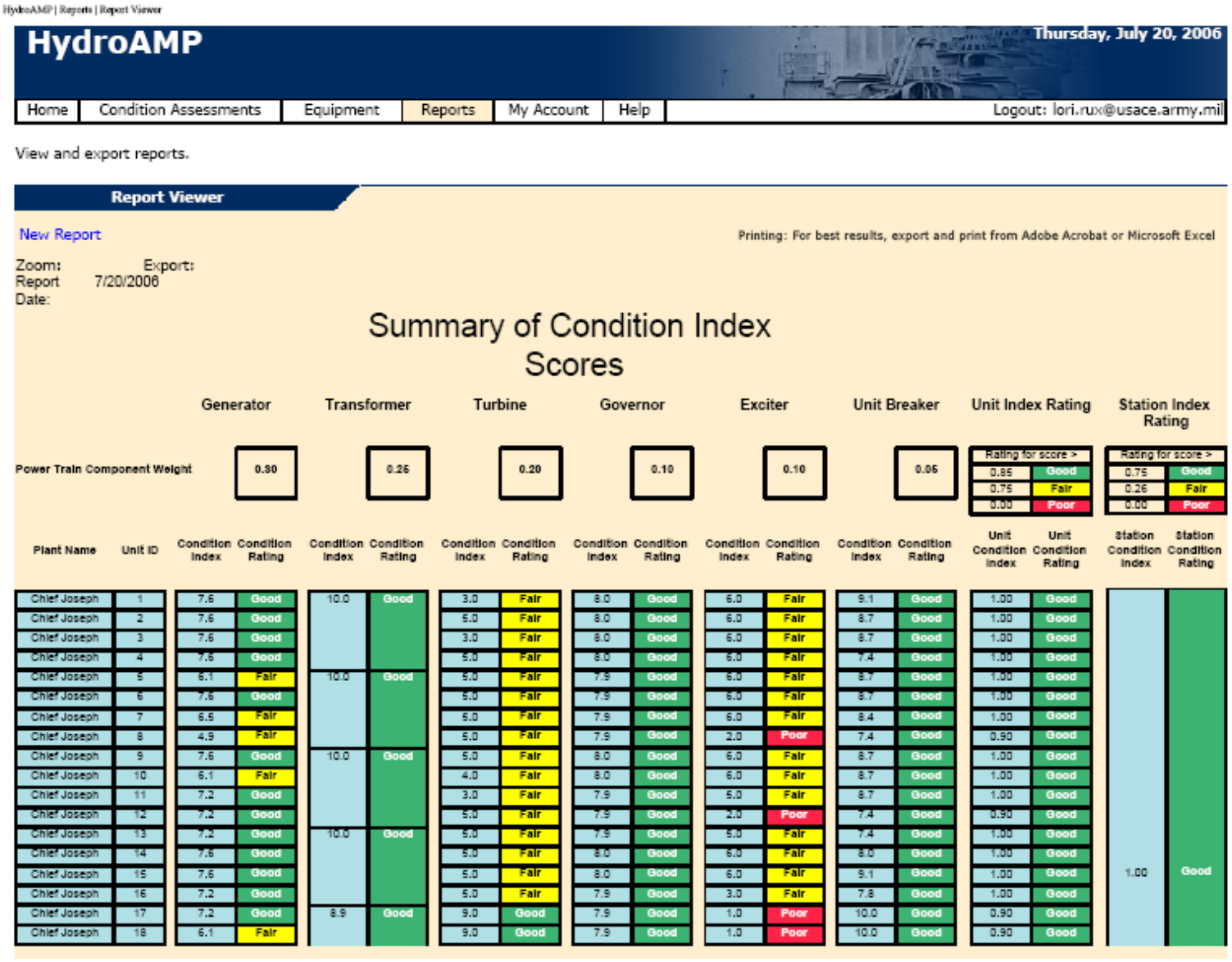
Report Date: 7/20/2006

## Generator Stator

| Plant Name | Unit # | Data Quality Score | Condition Index | Condition Rating |
|---|---|---|---|---|
| Chief Joseph | 1 | 10.0 | 7.6 | Good |
| Chief Joseph | 2 | 10.0 | 7.6 | Good |
| Chief Joseph | 3 | 10.0 | 7.6 | Good |
| Chief Joseph | 4 | 10.0 | 7.6 | Good |
| Chief Joseph | 5 | 10.0 | 6.1 | Fair |
| Chief Joseph | 6 | 10.0 | 7.6 | Good |
| Chief Joseph | 7 | 10.0 | 6.5 | Fair |
| Chief Joseph | 8 | 10.0 | 4.9 | Fair |
| Chief Joseph | 9 | 10.0 | 7.6 | Good |
| Chief Joseph | 10 | 10.0 | 6.1 | Fair |
| Chief Joseph | 11 | 10.0 | 7.2 | Good |
| Chief Joseph | 12 | 10.0 | 7.2 | Good |
| Chief Joseph | 13 | 10.0 | 7.2 | Good |
| Chief Joseph | 14 | 10.0 | 7.6 | Good |
| Chief Joseph | 15 | 10.0 | 7.6 | Good |
| Chief Joseph | 16 | 10.0 | 7.2 | Good |
| Chief Joseph | 17 | 10.0 | 7.2 | Good |
| Chief Joseph | 18 | 10.0 | 6.1 | Fair |

# hydroAMP Database: Station Summary Report

hydroAMP
Asset Management Partnership



HydroAMP | Reports | Report Viewer

HydroAMP

Thursday, July 20, 2006

Home | Condition Assessments | Equipment | Reports | My Account | Help | Logout: lori.rux@usace.army.mil

View and export reports.

Report Viewer

New Report

Printing: For best results, export and print from Adobe Acrobat or Microsoft Excel

Zoom: Export:
Report Date: 7/20/2006

## Summary of Condition Index Scores

| | Generator | Transformer | Turbine | Governor | Exciter | Unit Breaker | Unit Index Rating | Station Index Rating |
|---|---|---|---|---|---|---|---|---|
| Power Train Component Weight | 0.30 | 0.25 | 0.20 | 0.10 | 0.10 | 0.05 | Rating for score > 0.85 Good; 0.75 Fair; 0.00 Poor | Rating for score > 0.75 Good; 0.26 Fair; 0.00 Poor |

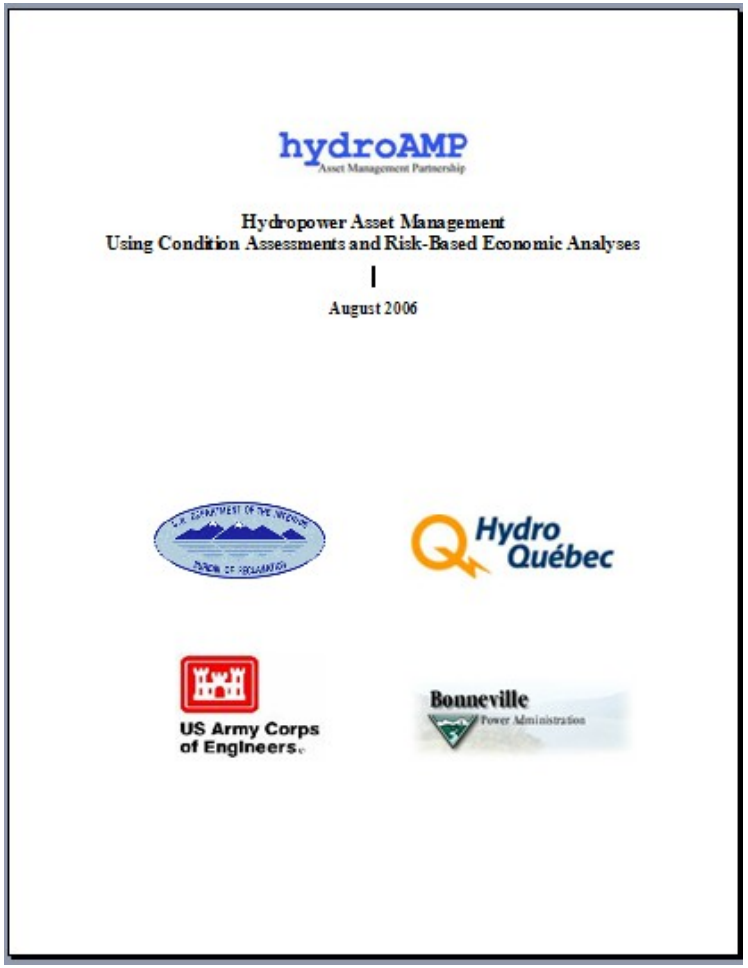
| Plant Name | Unit ID | Condition Index | Condition Rating | Condition Index | Condition Rating | Condition Index | Condition Rating | Condition Index | Condition Rating | Condition Index | Condition Rating | Condition Index | Condition Rating | Unit Condition Index | Unit Condition Rating | Station Condition Index | Station Condition Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chief Joseph | 1 | 7.6 | Good | 10.0 | Good | 3.0 | Fair | 8.0 | Good | 6.0 | Fair | 9.1 | Good | 1.00 | Good | 1.00 | Good |
| Chief Joseph | 2 | 7.6 | Good | | | 5.0 | Fair | 8.0 | Good | 6.0 | Fair | 8.7 | Good | 1.00 | Good | | |
| Chief Joseph | 3 | 7.6 | Good | | | 3.0 | Fair | 8.0 | Good | 6.0 | Fair | 8.7 | Good | 1.00 | Good | | |
| Chief Joseph | 4 | 7.6 | Good | | | 5.0 | Fair | 8.0 | Good | 6.0 | Fair | 7.4 | Good | 1.00 | Good | | |
| Chief Joseph | 5 | 6.1 | Fair | 10.0 | Good | 5.0 | Fair | 7.9 | Good | 6.0 | Fair | 8.7 | Good | 1.00 | Good | | |
| Chief Joseph | 6 | 7.6 | Good | | | 5.0 | Fair | 7.9 | Good | 6.0 | Fair | 8.7 | Good | 1.00 | Good | | |
| Chief Joseph | 7 | 6.5 | Fair | | | 5.0 | Fair | 7.9 | Good | 6.0 | Fair | 8.4 | Good | 1.00 | Good | | |
| Chief Joseph | 8 | 4.9 | Fair | | | 5.0 | Fair | 7.9 | Good | 2.0 | Poor | 7.4 | Good | 0.90 | Good | | |
| Chief Joseph | 9 | 7.6 | Good | 10.0 | Good | 5.0 | Fair | 8.0 | Good | 6.0 | Fair | 8.7 | Good | 1.00 | Good | | |
| Chief Joseph | 10 | 6.1 | Fair | | | 4.0 | Fair | 8.0 | Good | 6.0 | Fair | 8.7 | Good | 1.00 | Good | | |
| Chief Joseph | 11 | 7.2 | Good | | | 3.0 | Fair | 7.9 | Good | 5.0 | Fair | 8.7 | Good | 1.00 | Good | | |
| Chief Joseph | 12 | 7.2 | Good | | | 5.0 | Fair | 7.9 | Good | 2.0 | Poor | 7.4 | Good | 0.90 | Good | | |
| Chief Joseph | 13 | 7.2 | Good | 10.0 | Good | 5.0 | Fair | 7.9 | Good | 5.0 | Fair | 7.4 | Good | 1.00 | Good | | |
| Chief Joseph | 14 | 7.6 | Good | | | 5.0 | Fair | 8.0 | Good | 6.0 | Fair | 8.0 | Good | 1.00 | Good | | |
| Chief Joseph | 15 | 7.6 | Good | | | 5.0 | Fair | 8.0 | Good | 6.0 | Fair | 9.1 | Good | 1.00 | Good | 1.00 | Good |
| Chief Joseph | 16 | 7.2 | Good | | | 5.0 | Fair | 7.9 | Good | 3.0 | Fair | 7.8 | Good | 1.00 | Good | | |
| Chief Joseph | 17 | 7.2 | Good | 8.9 | Good | 9.0 | Good | 7.9 | Good | 1.0 | Poor | 10.0 | Good | 0.90 | Good | | |
| Chief Joseph | 18 | 6.1 | Fair | | | 9.0 | Good | 7.9 | Good | 1.0 | Poor | 10.0 | Good | 0.90 | Good | | |

https://secure.hpa.gov/hydroAMP/reports/index.aspx (1 of 2)7/20/2006 9:35:10 AM

# *Assessment Guides and Guidebook*

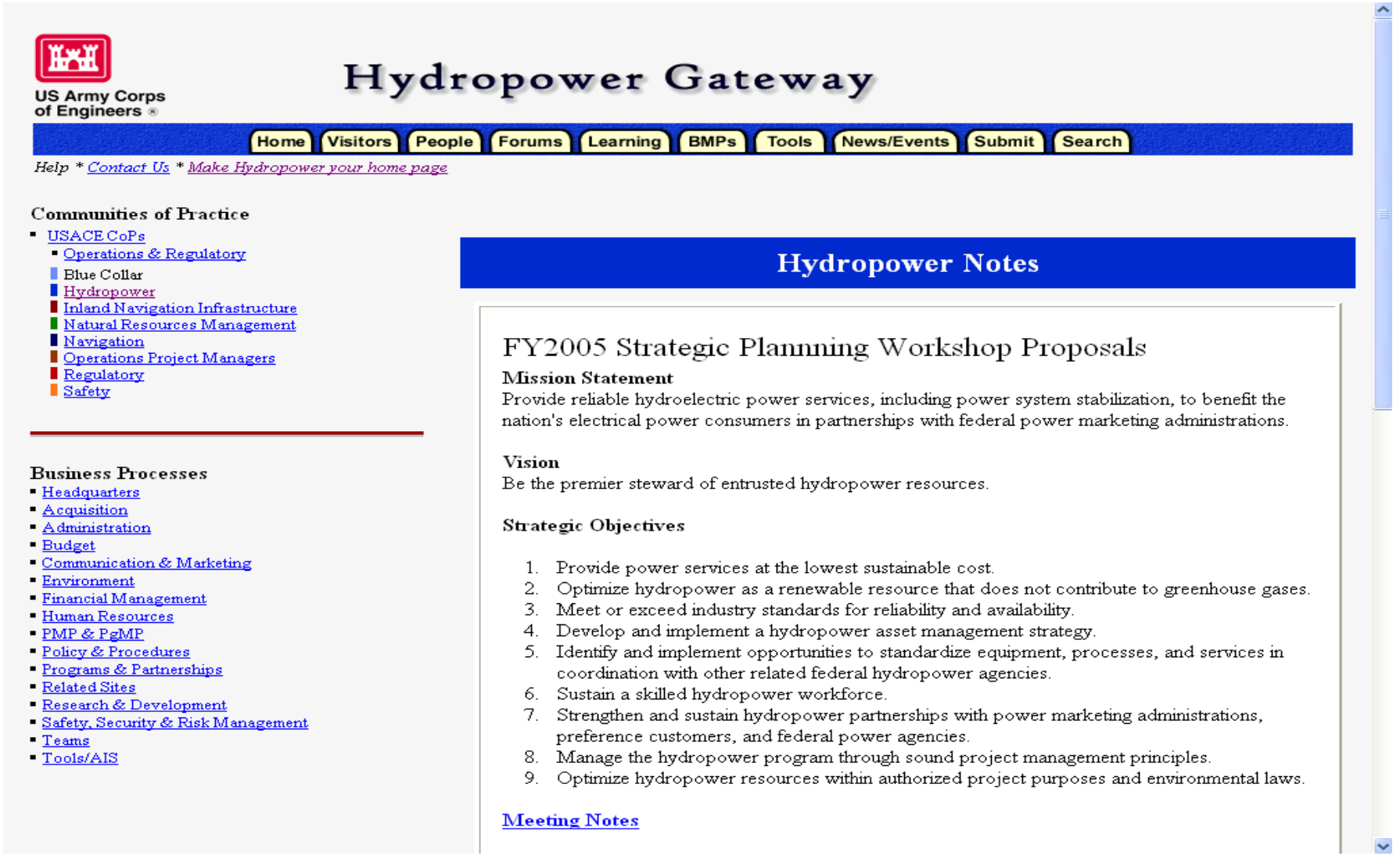
hydroAMP
Asset Management Partnership

- A guidebook was developed to facilitate asset management decisions using equipment condition assessments.
- The asset management tools are open and flexible to fit into the existing structure of each utility's maintenance, planning, budgeting and decision-making processes.



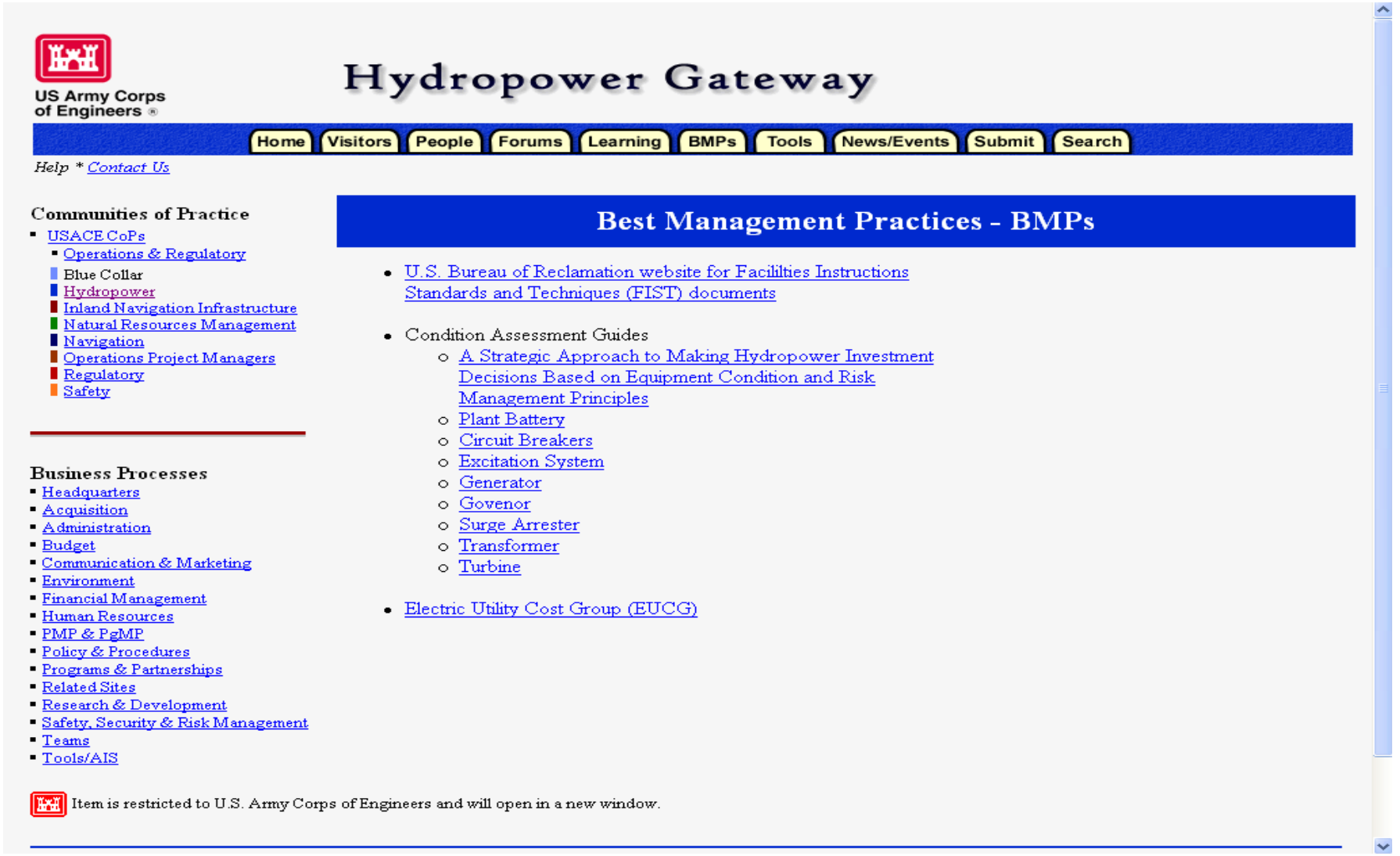
# http://operations.usace.army.mil/hydro.cf

hydroAMP
Asset Management Partnership


US Army Corps of Engineers
Hydropower Gateway
Home
Visitors
People
Forums
Learning
BMPs
Tools
News/Events
Submit
Search
Help * Contact Us * Make Hydropower your home page
Communities of Practice
USACE CoPs
Operations & Regulatory
Blue Collar
Hydropower
Inland Navigation Infrastructure
Natural Resources Management
Navigation
Operations Project Managers
Regulatory
Safety
Business Processes
Headquarters
Acquisition
Administration
Budget
Communication & Marketing
Environment
Financial Management
Human Resources
PMP & PgMP
Policy & Procedures
Programs & Partnerships
Related Sites
Research & Development
Safety, Security & Risk Management
Teams
Tools/AIS
Hydropower Notes
FY2005 Strategic Planning Workshop Proposals
Mission Statement
Provide reliable hydroelectric power services, including power system stabilization, to benefit the nation's electrical power consumers in partnerships with federal power marketing administrations.
Vision
Be the premier steward of entrusted hydropower resources.
Strategic Objectives
1. Provide power services at the lowest sustainable cost.
2. Optimize hydropower as a renewable resource that does not contribute to greenhouse gases.
3. Meet or exceed industry standards for reliability and availability.
4. Develop and implement a hydropower asset management strategy.
5. Identify and implement opportunities to standardize equipment, processes, and services in coordination with other related federal hydropower agencies.
6. Sustain a skilled hydropower workforce.
7. Strengthen and sustain hydropower partnerships with power marketing administrations, preference customers, and federal power agencies.
8. Manage the hydropower program through sound project management principles.
9. Optimize hydropower resources within authorized project purposes and environmental laws.
Meeting Notes

# http://operations.usace.army.mil/bmp.cfm?CoP=Hydro

hydroAMP
Asset Management Partnership



US Army Corps of Engineers

## Hydropower Gateway

Home | Visitors | People | Forums | Learning | BMPs | Tools | News/Events | Submit | Search

*Help * Contact Us*

**Communities of Practice**

- USACE CoPs
  - Operations & Regulatory
  - Blue Collar
  - Hydropower
  - Inland Navigation Infrastructure
  - Natural Resources Management
  - Navigation
  - Operations Project Managers
  - Regulatory
  - Safety

**Business Processes**

- Headquarters
- Acquisition
- Administration
- Budget
- Communication & Marketing
- Environment
- Financial Management
- Human Resources
- PMP & PgMP
- Policy & Procedures
- Programs & Partnerships
- Related Sites
- Research & Development
- Safety, Security & Risk Management
- Teams
- Tools/AIS

### Best Management Practices - BMPs

- U.S. Bureau of Reclamation website for Facilities Instructions Standards and Techniques (FIST) documents
- Condition Assessment Guides
  - A Strategic Approach to Making Hydropower Investment Decisions Based on Equipment Condition and Risk Management Principles
  - Plant Battery
  - Circuit Breakers
  - Excitation System
  - Generator
  - Govenor
  - Surge Arrester
  - Transformer
  - Turbine
- Electric Utility Cost Group (EUCG)

Item is restricted to U.S. Army Corps of Engineers and will open in a new window.

# *Conclusion*

hydroAMP Asset Management Partnership

hydroAMP condition assessments support:

- Need for further investigation.
- Repair and/or replacement decisions.
- Development and prioritization of long-term capital investments.
- Coordination of O&M practices at Regional, District, and Project levels.
- Identification and tracking of performance goals.

hydroAMP
Asset Management Partnership

***Thank you!***

Hydro Québec

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

US Army Corps of Engineers

Bonneville Power Administration